# Booster circuit enables reliable solenoid operation

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Solenoids at turn-on draw current that is much higher than the current needed to keep the armature pulled in. Further, because of the power dissipated in the coil, the solenoid's temperature will rise, and its dc resistance will increase. The applied voltage, therefore, must be increased to ensure reliable pull-in. Rather than increase the power supply voltage and current capability, this Design Idea presents a novel workaround based on a momentary voltage boost to turn on the solenoid.

The booster circuit operates from the existing supply voltage provided for the solenoid. Whenever the solenoid is to be switched on, the voltage-booster circuit is activated and charges a capacitor to approximately double the supply voltage. After the capacitor is charged (after 470 msec), it is connected to the solenoid. The charged capacitor provides additional energy that augments the nominal power source used to operate the solenoid. The circuit will reliably operate the solenoid under low-supply-voltage and high-temperature conditions. The booster circuit remains in standby mode after the solenoid is switched on.

The circuit in **Figure 1** is designed to drive a solenoid rated at a 12V dc, nominal, supply voltage and a 0.8A, nominal, current. The 12V supply used to operate the solenoid also powers the voltage-booster circuit. With power applied, but before the control signal is high—that is, when switch $S_1$ is open—the Q output of $IC_1$ (first one-shot, pin 6) is low. This keeps $IC_2$, a 555 timer IC, disabled. Note that pin 6 also wraps around to pin 4 to form a nonretriggerable one-shot. The Q output of the second one-shot is also low at this time.

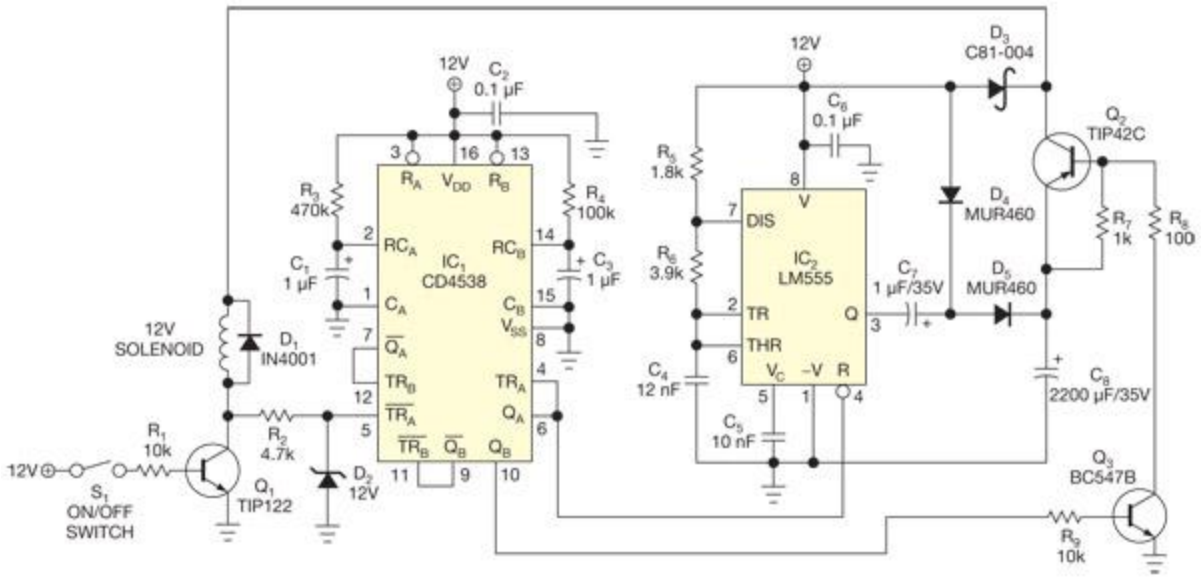


**Figure 1 The voltage-booster circuit is designed to drive a solenoid rated at a 12V dc, nominal, supply voltage and a 0.8A, nominal, current.**

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Closing switch $S_1$ turns on transistor $Q_1$, which grounds the low side of the solenoid coil and applies a low-going logic signal to the trigger input of the first one-shot ($IC_1$, pin 5). The Q output of $IC_1$ goes high for 470 msec and enables $IC_2$. $IC_2$ produces a rectangular waveform at its output (pin 3); through the voltage-doubler components ($C_7$, $D_5$, and $D_4$), $C_8$is charged to approximately 24V dc.

After the first one-shot times out and $\overline{Q}$goes high (pin 7), it triggers the second one-shot via the pin-12 input. This one-shot—also configured as nonretriggerable—produces a high-going pulse at its Q output (pin 10) of about 100 msec. This pulse turns on $Q_3$and $Q_2$ and applies 24V dc to the high side of the solenoid coil. As $C_8$ discharges, the 24V decays to 12V dc, the steady-state voltage for the solenoid; $D_3$ supplies the steady-state voltage to the solenoid.**Figure 2** shows the voltage waveforms.

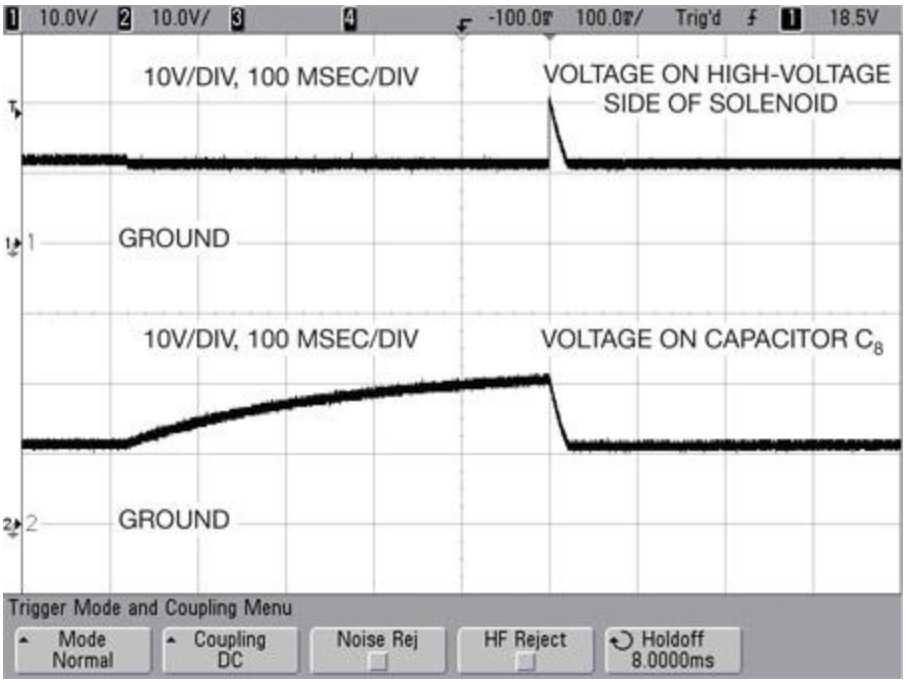


**Figure 2 As $C_8$ discharges, the 24V decays to 12V dc, the steady-state voltage for the solenoid; D3 supplies the steady-state voltage to the solenoid.**

To turn off the solenoid, remove the control signal by opening $S_1$. This action turns off transistor $Q_1$ but has no effect on the one-shot circuits.

In applications where multiple solenoids are to be switched on sequentially, you can effectively use the circuit with slight modification. Also, you can easily modify the circuit shown for solenoids operating from dc voltages other than 12V.